North Carolina Agricultural and Technical State University

Multi-Scale Interaction between Diurnal Cycle, MJO, and Equatorial Waves over the Maritime Continent (MC)

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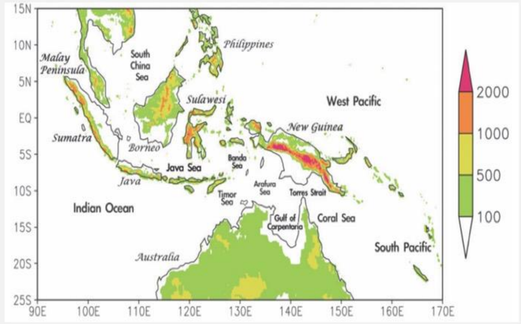
The Maritime Continent topographical map



Topographic Map of MC (Wu and Hsu 2009)

Tropical variabilities by duration:

- Diurnal variability (<2 days) ---- e.g. Diurnal Cycle
- Synoptic scale variability (2-10 days) --- e.g. Kelvin wave
- Intraseasonal variability (10-120 days) ---- e.g. MJO
- Interannual variability (year-to-year) --- e.g. ENSO

Introduction

- The diurnal cycle is a dominant component
- One of strongest in global tropics (Lin et al. 2000, Neale and Slingo 2003)
- Exhibits significant strength over land (afternoon) than over coast and ocean (morning).
- Influenced by island heating and land-sea breeze
- Associated with intense convection and organized systems
- Island heating forces convective systems to move offshore during evening

The MJO

- The Madden-Julian Oscillation (MJO) is dominant component of tropical intraseasonal variability
- Introduced by Madden and Julian in 1971, 1972, and 1994
- 40-50 day duration (Madden and Julian 1971, 1972) and later 30-90 day duration (Zhang 2005)

Kelvin Waves

- Kelvin wave is a synoptic (3-10 days) variability
- Equatorially trapped wave
- Compare to MJO it is;

✓ faster (~15 m/s),
✓ occurs over larger range of frequencies and wave numbers,
✓ more global scale, and
✓ more concentrated over equator

Data & Methods

Data:

- Tropical Rainfall Measurement Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA)
- TRMM Precipitation Features (PFs)
- International Satellite Cloud Climatology Project (ISCCP)
- European Center for Medium range Weather Forecast Reanalysis (ERA) Interim Reanalysis

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Diurnal Cycle of Rainfall and Convection over the Maritime Continent using TRMM and ISCCP

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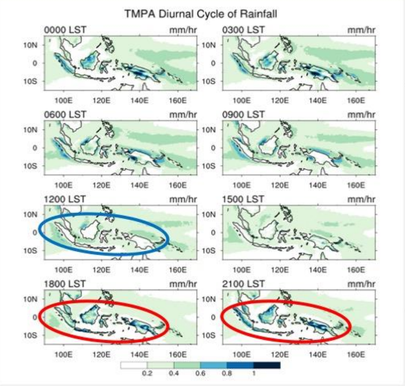
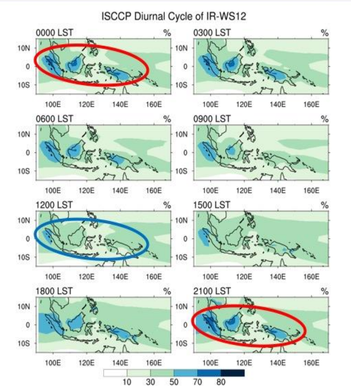
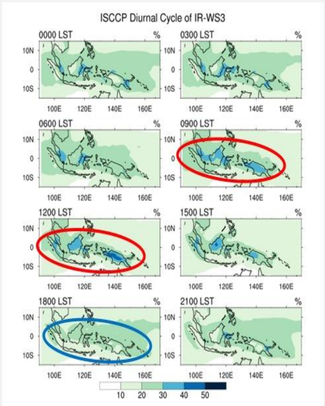


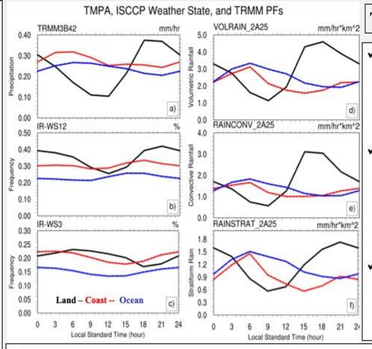
- ✓ Large islands (PNG / Borneo / Sumatra) peak at 2100 LST
- ✓ Coastal seas peak around 0600 LST
- ✓ Weaker cycles over off-shore
- ✓ Peak cycle over ocean around 0600 LST



- ✓ Peaks over larger islands at 2100 LST through early morning
- ✓ Moves west to coast and ocean early in the morning and peaks between 0000 and 0600 LST
- ✓ Minimum between 0900 and 1200 LST over land, coast, and ocean



- ✓ Over land peak at 1200 LST
- ✓ Peaks over coast between 0900 and 1200 LST
- ✓ Over ocean peak early in the morning around 0000 LST
- ✓ Over land and coast minimum at 1800 LST
- ✓ Over ocean minimum at 1500 LST



Timeseries Analysis

- ✓ **TMPA** rainfall peaks late in the afternoon over land and in the morning over coast and ocean
- ✓ **IR-WS12** peaks in the afternoon through late evening over land and noon through afternoon over coast ocean
- ✓ **IR-WS3** peaks in the early in the morning over land, coast, and ocean regions

- ✓ **Volumetric and Convective rain** peak over land early in the afternoon but **Stratiform rain** peak late in the afternoon
- ✓ **Volumetric, Convective and Stratiform rain** peak in the morning over coast and ocean regions

Summary

- ✓ IR-WS12 & rainfall peak in the afternoon over land
- ✓ IR-WS3 & rainfall peaks in the morning over coast and ocean
- ✓ Volumetric, convective, and stratiform rain features peak in the morning over coastal and oceanic regions
- ✓ Volumetric, convective, and stratiform rainfall have a strong correlation with IR-WS12 and TMPA rainfall over land
- ✓ In general, the diurnal cycle of rainfall is strong over land than offshore regions
- ✓ **The diurnal cycle over the MC is strong** – warrant additional research to understand modulation of it by the MJO and other equatorial waves that passes through the region

Modulation of Diurnal Cycle by the MJO and Equatorial Waves over the MC

Future Work

1. Identify dates with peak MJO-filtered rainfall at each 10^0 longitude from 60^0E to 180^0E
2. Calculate wave variance for each set of dates from (1)
3. Use the dates from (2) to modify the MJO events that propagate across the MC and that do not
4. Then investigate the interaction between the diurnal cycle, the MJO, and Kelvin wave